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(54) **Passive power supplies**

(57) A passive electrical power supply for providing electrical power to an electronic circuit, comprising an antenna 1, 2 for converting radio frequency signals into electrical signals, a transformer 6 for transforming electrical signals into further electrical signals capable of altering the impedance of a FET 17, which FET provides at its drain 10 a quasi half wave rectified representation of the electrical signals, which electrical signals are converted to a dc signal by a capacitor 18 connected to the drain of the FET, thereby providing a means for converting radio frequency energy into dc electrical energy for operating an electronic circuit, e.g. an electronic tag.

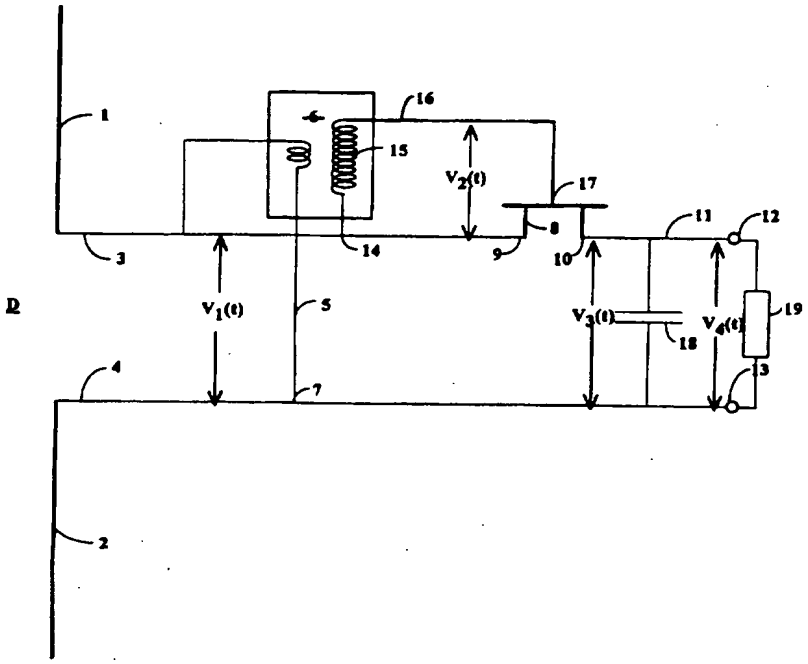

Fig. 1

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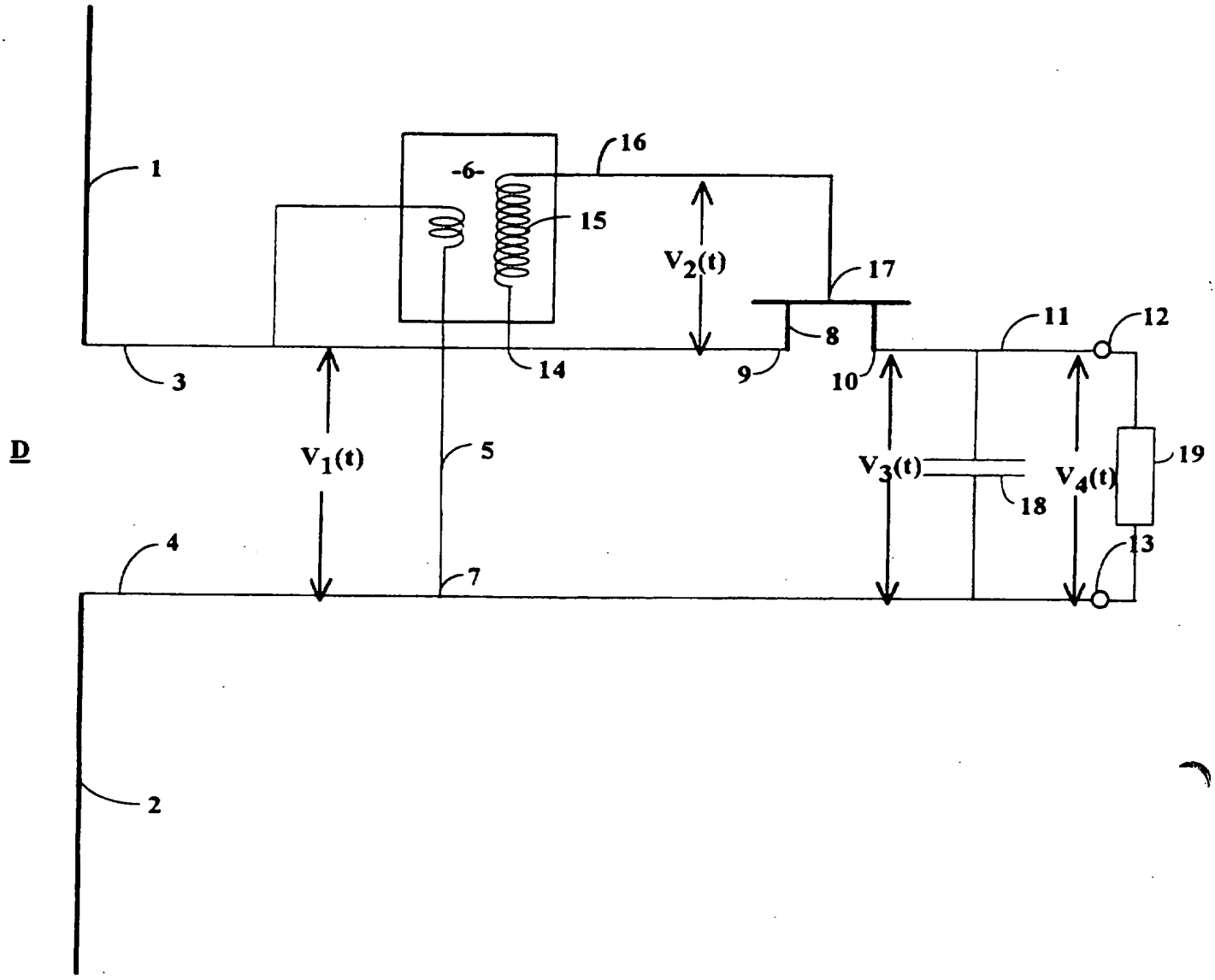

Fig. 1

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IMPROVEMENTS IN OR RELATING TO POWER SUPPLIES

The present invention relates to electrical power supplies and more particularly it relates to electrical power supplies which receive radiated electromagnetic energy in order to provide an electrical supply.

Power supplies which receive power from radio signals for example, are known, but such known supplies embody semiconductor devices which require a threshold voltage to be exceeded before the devices become active. Thus, it will be apparent that if the voltage of a received radio signal relied upon to provide energy for a power supply is not large enough to exceed the threshold voltage, the power supply will not function even though there may be sufficient energy available.

It is an object of the present invention to provide an electrical power supply which uses radiated electromagnetic radiation as an energy source and which will operate at low levels of received radiation.

According to the present invention an electrical power supply comprises an antenna for receiving electromagnetic radiation, 'step-up' transformer means, a primary winding of which is responsive to electrical signals produced in the antenna by such radiation, for producing at a secondary winding of the 'step-up' transformer means further electrical signals, a field effect transistor (FET) and capacitor means, wherein the secondary winding of the said transformer means is connected

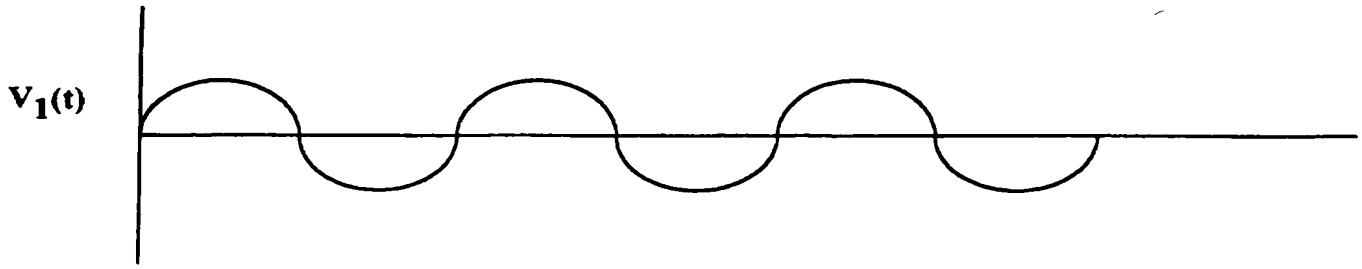

Fig. 2a

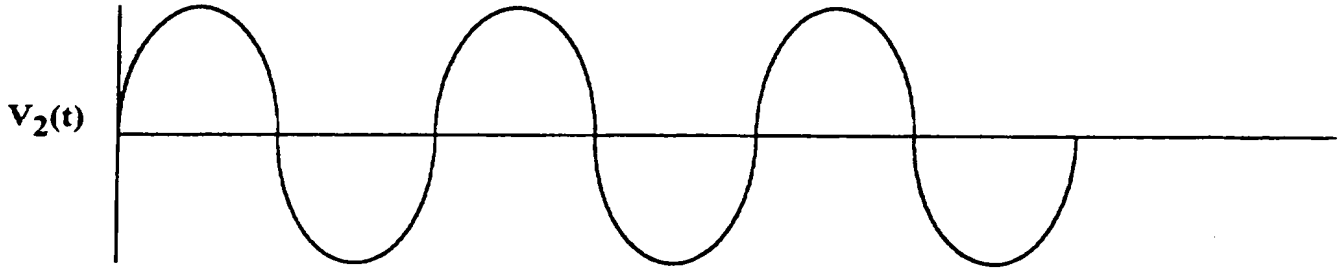

Fig. 2b

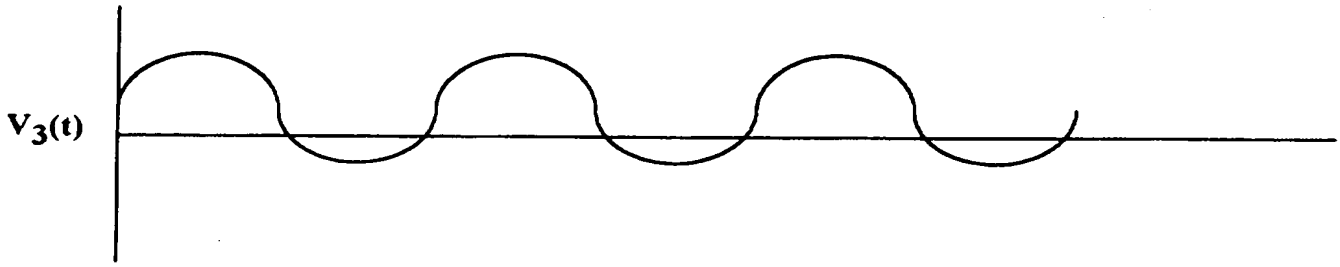

Fig. 2c

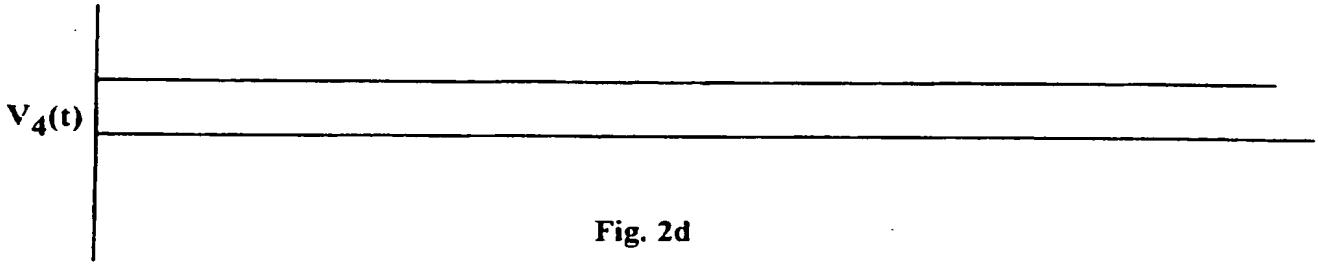

Fig. 2d

between source and gate terminals of the FET, and wherein the capacitor means is connected to a drain terminal of the FET and to the antenna, thereby to provide an output signal for the power supply in the presence at the antenna of received electromagnetic radiation.

Thus, the antenna of the power of supply operates to convert energy in the form of electromagnetic waves, which may comprise radio frequency signals, into energy in the form of an electrical signal. The electrical signal induces a voltage across the primary winding of the transformer, which appears as a larger voltage across the secondary winding of the transformer due to the 'step-up' turns ratio. This increased voltage is sufficient to alter the impedance of the FET so as to effect rectification of an ac signal produced at the source of the FET, and produce a rectified half wave signal at the drain of the FET. The FET performs a synchronous detector function that does not have a significant threshold at low signal levels. Thus, by using an FET rather than a rectifier device, an output DC signal is provided in the presence of very low level signals at the antenna, which would otherwise be insufficient to produce an output signal.

The capacitor means, which may be a discrete component, or which may simply comprise self capacitance of conductors, serves in effect as a low pass filter, which converts the rectified half wave signal into a dc signal.

The said source and said drain connections may be reversed.

The transformer means may be a double wound transformer.

The transformer means may be an auto-transformer.

The antenna may be a dipole.

The antenna may be a Yagi array.

The FET may be fabricated from Gallium Arsenide (GaAs).

One embodiment of the present invention will now be described by way of example only, with reference to the accompanying drawings in which:

FIGURE 1 is a somewhat schematic circuit diagram of an electrical power supply unit;

FIGURE 2a is a diagrammatic representation of an electrical signal at a point indicated as $V_1(t)$ in Figure 1;

FIGURE 2b is a diagrammatic representation of an electrical signal at a point indicated as $V_2(t)$ in Figure 1;

FIGURE 2c is a diagrammatic representation of an electrical signal at a point indicated as $V_3(t)$ in Figure 1;

FIGURE 2d is a diagrammatic representation of an electrical signal at a point indicated as $V_4(t)$ in Figure 1.

Referring now to Figure 1, a dipole D comprises first and second elements 1, 2. The first element 1, is connected to a conductor 3, and the second element 2 is connected to a conductor 4. A primary winding 5, of a 'step-up' transformer 6, is connected between the conductors 3 and 4 at two points 6 and 7. A field effect transistor 8, includes a source terminal 9, connected to the conductor 3, and a drain terminal 10 connected to a conductor 11. The conductor 11, and the conductor 4, respectively communicate with a pair of output terminals 12 and 13. One end 14, of a secondary winding 15, of the 'step-up' transformer 6, is connected

to the conductor 3, whereas the other end 16 is connected to a gate 17, of the FET 8. A capacitor 18, which in this example is a discrete component, but which may be defined by stray capacitances between the conductors 11 and 4, is connected in parallel with a load 19, which is connected between the output terminals 12 and 13.

The dipole D, serves to convert energy in the form of radio frequency electromagnetic waves into electrical signals. The electrical signals cause an ac electrical signal to be provided between the conductors 3 and 4, designated in Figure 1 as $V_1(t)$. A representation of the wave-form of this electrical signal $V_1(t)$ is shown in Figure 2a. The range of frequencies of electromagnetic energy which can be received and converted by the dipole is determined by its physical dimensions.

The transformer 6 serves to transform the electrical signal $V_1(t)$ to an electrical signal with an increased peak to peak voltage, which is generated between the terminals 14 and16 of the secondary winding 15. This transformed electrical signal is designated $V_2(t)$ in Figure 1. A representation of the signal $V_2(t)$ is shown in Figure 2b which illustrates the proportionate increase in voltage.

The voltage signal $V_2(t)$ is applied to the gate of the FET 8 and is sufficiently large to alter its impedance between the source 9 and the drain 10. This has the effect of rectifying the signal $V_1(t)$, although this may be an imperfect rectification. This is because in positive half cycles of $V_1(t)$, the FET conducts so that $V_1(t)$ appears at the drain 10. However, in negative half cycles

the impedance between the source 9 and the drain 10 is increased, thereby reducing the voltage which appears at the drain 10, to produce a signal designated $V_3(t)$ in Figure 1, and shown in Figure 2c. The signal $V_3(t)$ therefore represents a quasi half wave rectification of the signal $V_1(t)$ which is converted into a dc signal, designated $V_4(t)$ in Figure 1 and as shown in Figure 2d, due to low pass filtering action of the capacitor 18. A dc electrical voltage is thus produced at the output terminals 12 and 13, which drives a load 19 connected thereto.

The FET 8, shown in Figure 1, is preferably fabricated from GaAs, so as to provide appropriate impedances.

The power supply may be used to drive a load circuit which requires low power in operation and which is required to be sited remotely from the source of radiated electromagnetic radiation and which may for example be mobile.

One application of the power supply herein described may be for supplying electrical power to an electronic tag, as described in our co-pending patent application (F21111).

Various modifications may be made to the arrangements hereinbefore described without departing from the scope of the invention, and for example, the dipole D may alternatively comprise a Yagi array, and/or the transformer 6 may be an auto-transformer.

WHAT WE CLAIM IS:-

1. An electrical power supply comprising an antenna for receiving electromagnetic radiation, 'step-up' transformer means, a primary winding of which is responsive to electrical signals produced in the antenna by such radiation, for producing at a secondary winding of the 'step-up' transformer means further electrical signals, a field effect transistor (FET) and capacitor means, wherein the secondary winding of the said transformer means is connected between source and gate terminals of the FET, and wherein the capacitor means is connected to a drain terminal of the FET and to the antenna, thereby to provide an output signal for the power supply in the presence at the antenna of received electromagnetic radiation.

2. An electrical power supply as claimed in Claim 1, wherein the capacitor means is a discrete component.

3. An electrical power supply as claimed in Claim 1, wherein the capacitor means comprises the self capacitance of conductors.

4. An electrical power supply as claimed in any preceding Claim, wherein the source and drain are reversed.

5. An electrical power supply as claimed in any preceding Claim, wherein the transformer means is a double wound transformer.

6. An electrical power supply as claimed in any preceding Claim, wherein the antenna is a dipole.

7. An electrical power supply as claimed in any preceding Claim, wherein the FET is fabricated from Gallium Arsenide (GaAs).

8. An electrical power supply substantially as hereinbefore described with reference to the accompanying drawings.

9. An electronic tag including an electrical power supply as claimed in any preceding Claim.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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Databases (see over)

(i) UK Patent Office

(ii) On-line: WPI, CLAIMS, EDOC

Search Examiner
J BETTS

Date of Search
19 JANUARY 1996

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2232027 A (YAMATAKE-HONEYWELL)	
A	WO 88/00769 A1 (PHILLIPS)	